# Third-wave cognitive behaviour therapies for weight management: a systematic review and network meta-analysis

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Conflicts of interest:

AA is the Chief Investigator on two publically funded (MRC, NIHR) trials where the intervention is provided by WW (formerly Weight Watchers) at no cost outside the submitted work. AJH reports receiving personal fees from Slimming World, outside the submitted work. CAH reports education work and consultancy Oviva, Orexigen Therapeutics, Kastech, Ethicon, Mundipharma, Consilient Health, Nestle, and Novo Nordisk, outside the submitted work. ERL, NI, SB and SJG have no conflicts of interest.

Abbreviations:

BMI: Body mass index; CBT: Cognitive behaviour therapy; SBT: Standard behavioural treatment; SMD: Standardised mean difference; 3wCBT: Third-wave cognitive behaviour therapy; DBT: Dialectical behaviour therapy; ACT: Acceptance and commitment therapy; MBCT: Mindfulness-based cognitive behavioural treatment; CFT: Compassion focused therapy; RCT: Randomised controlled trail; SD: Standard deviation; CI: Confidence intervals.

## ABSTRACT

This systematic review and network meta-analysis synthesised evidence on the effects of third-wave cognitive behaviour therapies (3wCBT) on body weight, psychological and physical health outcomes in adults with overweight or obesity. Studies that included a 3wCBT for the purposes of weight management and measured weight or BMI pre-intervention and ≥3 months post-baseline were identified through database search [MEDLINE, CINAHL, Embase, Cochrane database (CENTRAL), PsycINFO, AMED, ASSIA and Web of Science]. Thirty-seven studies were eligible; 21 were randomised controlled trials (RCT) and included in the network meta-analyses. Risk of bias was assessed using RoB2 and evidence quality was assessed using GRADE.

Random-effects pairwise meta-analysis found moderate to high quality evidence suggesting that 3wCBT had greater weight loss than standard behavioural treatment (SBT) at post-intervention (SMD: -0.09, 95% CI: -0.22, 0.04; N=19; $I^2$=32%), 12-months (SMD: -0.17, 95% CI: -0.36, 0.02; N=5; $I^2$=33%) and 24-months (SMD: -0.21, 95% CI: -0.42, 0.00; N=2; $I^2$=0%). Network meta-analysis compared the relative effectiveness of different types of 3wCBT that were not tested in head-to-head trials up to 18 months. Acceptance and commitment therapy (ACT)-based interventions had the most consistent evidence of effectiveness. Only ACT had RCT evidence of effectiveness beyond 18 months. Meta-regression did not identify any specific intervention characteristics (dose, duration, delivery) that were associated with greater weight loss.

Evidence supports the use of 3wCBT for weight management, specifically ACT. More large trials with long-term follow-up are needed to identify who these

interventions work for, their most effective components, and the most cost-effective method of delivery.

## BACKGROUND

Although behavioural interventions are effective at helping people to lose weight, many people struggle to sustain effective weight management behaviours over extended periods due to a combination of biological, psychological, social and environmental factors that drive weight gain.[1,2] Standard behavioural programmes can be effective in the short-term, but less so in the longer term.[3–6] These usually combine diet and physical activity advice with core behavioural change techniques including goal setting, self-monitoring, problem solving, and planned social support.[7] It has been proposed that third-wave cognitive behaviour therapies (3wCBT), including acceptance and commitment therapy (ACT), dialectical behaviour therapy (DBT), mindfulness-based cognitive behavioural therapy (MBCT) and compassion-focused therapy (CFT),[8–10] may have better short- and long-term outcomes.[2]

The theoretical case for 3wCBT for weight management has been well articulated.[2] In brief, these therapies encourage people to accept aversive internal experiences (e.g., food cravings, physical discomfort) rather than avoid them. Increased present-moment, non-judgemental awareness and psychological flexibility may assist an individual in recognizing internal and external cues to overeat, and alter behavioural responses to be more in line with their values. Fostering a compassionate attitude towards the self could also help prevent discouragement following minor lapses.[2,8,9]

However, the evidence of their superior effectiveness is less clear. Previous systematic reviews and meta-analyses primarily focused on mindfulness and/or acceptance-based interventions.[11–18] Three reviews[13,15,16] have reported a

quantitative synthesis of pre-post change without comparing the effect against a comparator. Two of these three reviews reported a 'small' pre-to-post change in weight[15] or BMI[13] while the other study[16] reported a null effect on BMI. Critically, only one review[14] reported a meta-analytic synthesis that compared the effectiveness of mindfulness and acceptance-based interventions to those in other active interventions and control arms using appropriate statistical methods. A small but significant difference in weight or BMI was reported at post-intervention, favouring mindfulness and acceptance-based interventions over comparator arms. Subgroup analysis suggested that the effect may only hold when the comparator is waitlist control. In that review, there was no restriction on the minimum follow-up duration and outcomes were analysed at one month post intervention (or the closest measurement to this). Thus, the pooled estimates reflected a mix of very short-term and longer-term effects. Moreover, without a restriction on minimum BMI, these findings are less relevant from a policy perspective since behavioural weight management programmes are intended for adults with overweight/obesity.[19,20] This concern is compounded by the finding that a lower BMI was associated with a larger effect size.

To our knowledge, no head-to-head trial exists that has compared the effectiveness of different types of 3wCBT on weight management. In the absence of head-to-head trials, network meta-analysis can estimate the indirect evidence on the comparative effectiveness of different types of 3wCBT. The proposed mechanism for the superior effects of 3wCBT is through improvements in eating behaviour and psychological outcomes, so it is also important to synthesise evidence on the impact of 3wCBT on these outcomes. In addition, evidence synthesis of the effect of 3wCBT on eating

behaviour and psychological outcomes has been limited to pre-post change[13,15,16] and has not considered longer follow-up periods.

To address these knowledge gaps, we conducted the most comprehensive, inclusive, and relevant review and quantitative synthesis of available evidence to date. We included different types of 3wCBT beyond mindfulness and acceptance-based interventions. Our main objectives were (i) to evaluate the effectiveness of 3wCBTs on weight management by pooling the pre-post change effect estimates across all study types, (ii) to compare the effectiveness of 3wCBTs on weight management against no/minimal interventions and standard behavioural treatment separately using random-effects pairwise meta-analysis of RCTs, (iii) to estimate the comparative effectiveness of different types of 3wCBTs on weight management using random-effects network meta-analysis of RCTs, (iv) to evaluate the impact of 3wCBT on eating behaviour and psychological and physical health outcomes, and (v) to provide a detailed description of intervention characteristics and to identify whether any of these are associated with better weight change outcomes by using meta-regression.

## METHODS

### Protocol and registration

The protocol was registered on Prospero (CRD42018088255) prior to article screening.[21]

### Eligibility criteria

Participants were community-dwelling adults (≥18 years) with overweight or obesity (BMI ≥25 kg/m$^2$) seeking assistance with weight management. Studies had to include

a 3wCBT intervention for the purpose of weight management. Multi-component interventions (e.g. including diet and PA advice) were acceptable, with no restriction placed on the proportion of the intervention using 3wCBT. Interventions could be of any duration. Comparisons were (1) no/minimal intervention, (2) standard behavioural treatment (SBT) or (3) no comparator (single-arm pre-post studies). We defined SBT as structured programmes providing diet and/or physical activity advice and standard behaviour change techniques (e.g. goal setting, self-monitoring, problem solving, social support). The primary outcome was body weight or BMI. Studies needed to measure this pre-intervention and at least 3-months post-baseline. Secondary outcomes were stress, anxiety, depression, meta-cognition, eating attitudes, eating behaviours, body satisfaction, quality of life, blood pressure, lipids, glycaemia and adherence to treatment. All outcomes reported at 3-months from baseline and beyond were extracted. All settings apart from laboratories were eligible. We included research articles, theses and dissertations reporting randomised control trials (RCTs), non-RCTs, prospective cohort and case series studies.

**Information sources**

Databases (MEDLINE, CINAHL, EMBASE, Cochrane database (CENTRAL), PsycINFO, AMED, ASSIA and Web of Science) were searched by ERL from inception with no restrictions, using keywords and subject heading searches relating to the concepts: (1) Third-wave CBTs AND (2) Overweight, obesity or weight management (see Table S1). The initial search was conducted on the 16th January 2018, and an updated search was conducted on 25th September 2019. Reference lists of eligible studies and relevant reviews were searched and authors of relevant

abstracts were contacted to identify whether findings had been accepted for publication.

### Study selection

Titles and abstracts, then full texts, were screened independently by two of three researchers, with a third reviewer adjudicating uncertainty or disagreement. Study authors were contacted to resolve any questions about eligibility. Non-English language texts were translated into English by colleagues who were fluent in that language.

### Data collection process

Data were extracted independently by two of four researchers using a form based on the Cochrane data extraction form,[22] the Consolidated Standards of Reporting Trials 2010 statement[23] and the Template for Intervention Description and Replication checklist,[24] and cross-checked for consistency. Attempts were made to contact authors to retrieve missing data. If there was no response after two attempts, we used the data available in the published work.

### Risk of bias

Two researchers assessed studies independently using the Risk of Bias 2 tool[25] or the Risk of Bias in Non-randomised studies of Interventions tool,[26] dependent upon study design. A third reviewer adjudicated inconsistency. The quality of evidence was assessed using the Grading of Recommendations Assessment, Development and Evaluation approach, which classifies studies as ‘high’, ‘moderate’, ‘low’ or ‘very low’ quality.[27]

## Missing data

For the primary outcomes, where SDs for mean change were missing and not provided following author correspondence, these were imputed using the following methods, in order of prioritisation: i) imputed from other time-points within same study, ii) estimated from t-statistics, Cohen's d, p-values or confidence intervals,[28–32] iii) estimated using a correlation coefficient of 0.97, based on empirical data from seven studies[28,30,33–37] (17 estimates) that reported SDs for baseline, follow-up, and mean change.[38–46] Insufficient data prevented this approach for secondary outcomes, so we used a correlation of 0.7 as in previous studies.[47,48]

## Synthesis of results

Stata/SE v.14.2[49] was used for all the statistical analyses. Following guidance,[50] we focused on 95% confidence intervals (CI), rather than statistical significance. For example, unlike conventional interpretations, we did not outright interpret an effect estimate 'non-significant' if the lower or upper bound of the 95% CI was slightly above/below the null value; we interpreted them as 'suggestive' of an effect.

*Pooled estimates of intervention-specific effects from all study types*

Intervention-specific effects (post-intervention minus pre-intervention) were estimated by pooling effect estimates from all study designs. Due to heterogeneity in outcome measurement, effect estimates were reported as standardised mean change from the random-effects meta-analysis.[51] Effect estimates were reported at the earliest measurement post-intervention (≥3 months from baseline) and at 3-, 6-, 9-, 12-, 18-, 24-, and 36-months from baseline. Outcomes falling between these time-points were included with the closest time-point.

*Intervention comparisons: Direct evidence from pairwise meta-analysis of RCTs*

The direct effect comparing 3wCBT against (i) no/minimal intervention and (ii) SBT was estimated using random-effects[51] pairwise meta-analysis of RCTs. The standardised mean difference (SMD) calculated using Hedges' method and 95% CI were reported.[52]

*Intervention comparisons: Indirect and mixed evidence from network meta-analysis of RCTs*

To compare types of 3wCBT, random-effects network meta-analysis of RCTs was conducted to estimate the indirect and mixed (direct plus indirect) evidence.[53] Basic assumptions were checked conceptually and statistically.[53] For example, to avoid violating the transitivity assumption, which requires the comparator arm (e.g., the waitlist control) is comparable across the trials, the comparators (SBT and no/minimal intervention) were not pooled/used together. Similarly, the intervention arms were dropped (namely resistance exercise[35] and food environment modification[54]) if they were not comparable with other intervention arms. The consistency assumption was checked statistically to see if the direct and indirect effect estimates were comparable enough to pool them together into the mixed evidence.[55,56] Effect estimates were reported as SMD and 95% CIs. The relative ranking probability of each intervention being the best treatment was estimated using Rankograms.[57]

*Sensitivity analysis*

The influence of individual studies on weight change of 3wCBT compared to no/minimal intervention or SBT was examined using influence plots, where one study was removed at a time to see its effect on the overall estimate[58].

*Meta-regression on intervention and study characteristics*

Where at least 10 studies provided relevant data,[59] meta-regression was used to identify potential sources of heterogeneity for pre-specified characteristics: number of sessions (continuous; <12 vs. ≥12 sessions), duration of intervention (<3 months vs. ≥3 months, <6 months vs. ≥6-months), method of delivery (face-to-face vs. remote; group vs. individual) and risk of bias (low, some concerns, high).

*Secondary outcomes*

Only a small number of studies reported the secondary outcomes at each follow-up time-point, so the first time-point post-intervention was used and network meta-analysis was not conducted. Pooled and pairwise meta-analyses were conducted for secondary outcomes reported in ≥2 studies.

For consistency, we defined 'change' as post-intervention minus pre-intervention values; so a negative 'change' estimate indicates that the outcome decreased after the intervention.

## RESULTS

After duplicate removal, 8755 titles and abstracts were screened and 215 full text articles were assessed. Two additional studies and four articles related to already included studies were identified from reference lists,[60–64] and contacting an author.[65] Fifty articles reporting 37 studies met the inclusion criteria (Figure 1). Two studies were excluded from the meta-analyses due to co-interventions (pharmacotherapy[66] and bariatric surgery[39]). 35 studies were used in the pooled-effects meta-analysis of pre-post changes and the 21 RCT design studies were used in the network meta-analysis that compared different interventions.

Figure 1: PRISMA flow diagram

## Study characteristics

Seventeen studies[30–33,36,41,45,46,66–74] used a two group RCT, four[35,40,44,54] used a three group RCT and one used a two group cluster RCT design.[42] Fourteen studies[28,29,34,38,43,64,65,75–80] used a pre-post one group design, and one study was a non-randomised three group study.[39] The majority of studies were conducted in the USA (n=28). The other studies were conducted in New Zealand,[34] Italy,[39] UK,[41,42,77] the Netherlands,[43,64] Finland[44] and Portugal[70] (Table 1).

*Table 1: Characteristics of included studies*

*Participant characteristics*

Studies included 2726 participants and the sample size ranged from ten[29,64] to 283.[54] Seventy-five percent of participants were female (n=2035/2726), with twelve studies[28,32–34,38,45,64,65,67,70,80] focusing exclusively on females. Mean age was 46 years (ranged from 21[33] to 58 years[45]), and mean BMI was 35.6 kg/m$^2$ (Table 1 & Table S2a&b).

*Intervention Characteristics*

Twenty-two studies evaluated MBCT[28,29,31–33,35,36,38,40,42,45,46,64,65,67–70,74,77,78], eleven evaluated ACT-based interventions[30,34,44,54,71–73,75,76,79,80], three evaluated DBT [39,43,66] (one[66] in combination with pharmacotherapy), and one evaluated CFT.[41] Twenty-seven studies[28–33,35,36,40,44–46,64,65,67–73,75,77,78,80,81] used primarily face to face, group

format delivery. One study[43] had an initial individual face to face session before delivery of group sessions. Five other studies[38,39,41,42,66] used face to face group sessions along with another mode: emails,[42] telephone calls,[39,41] individual diet counselling[38] and a website for pharmacology support.[66] One study[76] used individual face to face lifestyle counselling and telephone delivery. Three delivered interventions on an individual, remote basis using email[74] and online website,[34,79] two of these included telephone support.[74,79] One study[44] had two intervention arms with the same content delivered face to face or through mobile telephone. Most interventions include home-based skills practice between sessions.

Intervention duration varied, with two lasting less than a week,[28,30] twelve studies between one and 3 months,[29,32,33,36,42,44,65,66,77,79,80] and nine studies[31,34,40,43,67,68,70,76,78] between 3½ and 5½ months in length. Thirteen studies lasted for 6 months or more, with five of these being 12 months in length.[39,45,54,72,73] Hamel et al[64] did not report intervention length.

All studies were delivered on a weekly or alternating weekly basis, apart from two: a one-off one day workshop and 5-day residential retreat.[28,30] Several interventions had an "active phase", then an extended period with less regular sessions or telephone follow-up.[38,40,45,54,68–73] Most interventions were implemented at a university,[30,35,36,40,42,45,46,54,66,68] with other venues including primary care units and hospitals,[41,70,76,77] yoga retreat centres,[28,65] a community and oncology practice,[38] YMCA,[29] and participants' place of employment[80] (Table 1 and Table S3a&b).

**Risk of bias**

Of the RCTs, the risk of bias was rated as 'high' in four,[36,41,42,74] 'some concern' in eleven[30,31,33,35,40,45,46,66,69–71] and 'low' in seven studies[32,44,54,67,68,72,73] (Table S4a). Of the 15 non-RCTs, the risk of bias was rated as 'serious' in nine,[28,38,39,64,65,78–80] and 'moderate' in six[29,34,43,75–77] studies (Table S4b). The quality of the evidence was different for different comparisons, dependent on studies included. For the comparison between 3wCBT and no/minimal intervention at post-intervention the quality of evidence was high (3 studies);[40,44,67] for the comparison between 3wCBT and SBT, the quality of evidence was moderate at post-intervention (19 studies),[30–33,35,36,40–42,45,46,54,68–74] and high at 12 months (5 studies),[45,54,68,72] 18 months (3 studies),[68,71,73] 24 months (2 studies)[72,73] and 36 months (1 study,[72] direct evidence only) from baseline. Details of study quality for all comparisons are reported Table S5a-c.

**Intervention effects on body weight or BMI**

Twenty five studies[28–33,35,36,38,42,44–46,54,65,67–69,73–78] reported an absolute weight change (kg or lb), four studies[71,72,79,80] reported percent change from baseline weight, and six studies[34,40,41,43,64,70] reported BMI change.

***Pooled estimates of intervention-specific effects from all study types***

Standardised mean change in weight or BMI for 3wCBT was -0.84 (95% CI: -1.06, -0.62; N=35; $I^2$=93%) from baseline to post-intervention (equating an absolute weight change of 5.5kg). Weight change by types of 3wCBT at different time-points is reported in Table S6. There was a pattern of weight loss (relative to baseline) for DBT up to 12-months, for MBCT up to 18-months, and for ACT up to 36-months. However, there was high heterogeneity and few studies at later time points. There

was no evidence of weight loss following CFT, but this was based on one poor quality study[41] at a single 3 month follow-up from baseline

***Intervention comparisons: Direct evidence***

Figure 2 summarises the results of the pairwise random-effects meta-analysis, and Table S5a presents the quality of evidence for all direct comparisons using GRADE.[27] Most individual studies were small and did not find evidence of a difference between interventions. However, when findings were meta-analysed, there was high quality evidence to suggest greater weight loss for 3wCBT compared to no/minimal intervention at post-intervention and 9-months follow-up from baseline. There was moderate quality evidence based on 19 studies[30–33,35,36,40–42,45,46,54,68–74] suggesting that 3wCBT had greater weight loss than SBT at post-intervention, and high quality evidence suggesting that 3wCBT had greater weight loss than SBT at 12-months (5 studies[45,54,68,72]), and 24-months (2 studies[72,73]). Only ACT interventions provided data for the 24-month comparison. Estimates at 6- and 18-months also suggested greater weight loss for 3wCBT vs. SBT, but there was no evidence of a difference between the two groups at 3- and 9-months.

**Sensitivity Analysis**

In the influence plot analysis, removal of one study at a time did not have any effect on the overall effects estimates from the pairwise meta-analysis of weight change.

*Figure 2: Weight change comparing third-wave CBT and no/minimal or standard behavioural treatment from random-effects pairwise meta-analysis*

***Intervention comparisons: Indirect and mixed evidence***

Network meta-analysis was conducted up to 18-months post-baseline, as only a single pairwise comparison (ACT vs. SBT) was reported at 24- and 36-months. Intervention networks at each time-point are summarised in Figure 3. Estimates from the network meta-analysis are summarised in Figure 4. ACT produced greater weight loss than no/minimal intervention at post-intervention and 9-months; comparisons at 3- and 6-months, however, did not provide evidence of superior effectiveness of ACT. Comparisons between ACT and SBT suggested greater weight loss for ACT post-intervention; there was no evidence of a difference at other time-points. Compared to MBCT, ACT had greater weight loss at 9-months; comparisons at other time-points did not show evidence of a difference.

Comparisons between no/minimal intervention and MBCT did not provide evidence of a difference at any time-point and there was no consistent pattern of effects. Comparisons between MBCT and SBT suggested that SBT was more effective at 9-months, but estimates at 12- and 18-months suggested MBCT was favoured. When CFT was compared to the other interventions, confidence intervals were wide with no comparisons favouring CFT.

When interventions were relatively ranked, ACT was the best intervention post-intervention and at 3-, 6- and 9-months post-baseline. MBCT was the best-ranking intervention at 12- and 18-months post-baseline, however this was based on only 5 studies (2 MBCT) and 3 studies (1 MBCT) respectively (Figure S1).

*Figure 3: Network of interventions at different follow-up time*

*Figure 4: Summary of weight change from network meta-analysis*

In terms of absolute weight change, for example, the SMD in weight between 3wCBT and SBT equates to a difference of 0.6kg post-intervention and 1.4kg at 24 month follow-up from baseline.

**Interventions effects on secondary outcomes**

Pooled arm-specific estimates (standardised mean change) of the effect of 3wCBT (combined) on secondary outcomes are presented in Figure S2. Pairwise estimates (SMD) from RCTs comparing 3wCBT and no/minimal intervention are presented in Figure S3; those comparing 3wCBT and SBT are presented in Figure 5 (a, b and c).

**Psychological outcomes**

Pooled arm-specific estimates showed a reduction in anxiety (N=7),[29,30,32,33,67,69,74] depression (N=9),[29,30,32,33,40,43,69,74,78] and stress (N=8)[28–30,32,36,67,74,78] following 3wCBT. When compared to no/minimal intervention, estimates suggested greater reductions in anxiety for 3wCBT (N=1)[67], a greater reduction in depression for 3wCBT (N=1),[40] but found no evidence of a difference in stress (N=1)[67]. Pairwise comparisons found no evidence of differences between 3wCBT and SBT for anxiety (N=5),[30,32,33,69,74] depression (N=6)[30,32,33,40,69,74] or stress (N=4).[30,32,36,74]

Pooled arm-specific estimates (N=4)[64,70,78,80] suggested an increase in quality of life (QoL) following 3wCBT. One study[70] reported a greater increase in QoL in 3wCBT vs. SBT.

Pooled arm-specific estimates (N=9)[32,35,36,42,44,46,69,70,80] showed an increase in mindfulness with 3wCBT. The estimate from one study[44] suggested a greater increase in mindfulness for 3wCBTs vs. no/minimal intervention. Pairwise estimates (N=7)[32,35,36,42,46,69,70] suggested a greater increase in mindfulness in 3wCBT vs. SBT.

Pooled arm-specific estimates (N=5)[30,34,44,74,75] showed that psychological flexibility increased after 3wCBT. One study[44] showed a greater increase in psychological flexibility for 3wCBT vs. no/minimal intervention. Pairwise estimates (N=2)[30,74] found no evidence of a difference between 3wCBT and SBT.

**Eating behaviour**

Pooled arm-specific estimates showed a decrease in binge eating (N=6),[29,33,40,45,74,78] disinhibition (N=14),[29,35,40,41,43,44,46,67,69,70,73,75,78,80] and hunger (N=7)[29,35,40,46,69,75,78] and suggested a decrease in emotional eating (N=13)[31,35,41,43,44,64,65,67,70,74,77,80] following 3wCBT. Compared to no/minimal intervention, three studies showed a greater decrease in disinhibition favouring 3wCBT,[40,44,67] one study[40] reported a greater decrease in binge eating and hunger favouring 3wCBT, and two studies[44,67] showed a greater decrease in emotional eating favouring 3wCBT. Pairwise estimates comparing 3wCBT and SBT found a greater decrease in disinhibition for 3wCBT (N=7),[35,40,41,46,69,70,73] but no evidence of a difference between the groups in binge eating (N=4),[33,40,45,74] hunger (N=4)[35,40,46,69] or emotional eating (N=5).[31,35,41,70,74] Pooled arm-specific estimates showed an increase in dietary restraint (N=12),[29,35,40,41,43,44,46,67,69,75,78,80] intuitive eating (N=2),[34,44] and mindful eating (N=6)[36,38,64,65,74] following 3wCBT. Pairwise estimates comparing 3wCBT and no/minimal intervention showed a greater increase in dietary restraint (N=3)[40,44,67] and a greater increase in intuitive eating (N=1)[44] in the 3wCBT group. Pairwise estimates comparing 3wCBT and SBT found a greater increase in mindful eating for 3wCBT (N=2)[36,74] but no evidence of a difference in dietary restraint (N=5).[35,40,41,46,69] No studies compared intuitive eating in 3wCBT vs. SBT.

Pooled estimates (N=6)[33,35,43,65,78] showed no evidence of a change in body dissatisfaction following 3wCBT; pairwise comparisons showed no evidence of a difference between 3wCBT and SBT (N=2).[33,35]

**Physical health outcomes**

Pooled arm-specific estimates (N=4)[30,32,36,68] suggested a reduction in diastolic blood pressure and systolic blood pressure following 3wCBT, but pairwise estimates showed no evidence of differences between 3wCBT and SBT. Pooled arm-specific estimates (N=3)[32,68,69] suggested a reduction in fasting glucose and $HbA_{1c}$ following 3wCBT, and pairwise estimates suggested greater reductions in fasting glucose and $HbA_{1c}$ for 3wCBT vs. SBT. There was no evidence of changes in high density lipoprotein cholesterol (N=1),[68] low density lipoprotein cholesterol (N=2),[32,68] or total cholesterol (N=1) following 3wCBT,[70] and no evidence of differences between 3wCBT and SBT in any of these outcomes. One study[68] reported a decrease in triglyceride and triglyceride-to-HDL ratio following 3wCBT, and a greater decrease of triglyceride in 3wCBT compared to SBT with no evidence of a change for triglyceride-to-HDL ratio between 3wCBT and SBT. Pooled arm-specific estimates (N=6)[36,42,68–70,76] showed a decrease in waist circumference following 3wCBT, but pairwise comparisons found no evidence of a difference between 3wCBT and SBT.

*Figure 5: Changes in secondary outcomes comparing third-wave cognitive behaviour therapy and standard behavioural treatment at earliest time point post-intervention using random-effects pairwise meta-analysis*

*5a: Psychological outcomes*

*5b: Eating behaviours*

*5c: Physical health outcomes*

## Meta-regression of intervention characteristics

A sufficient number of studies for meta-regression (N≥10) was only available at post-intervention and at 3- and 6-months since baseline for 3wCBTs vs. SBT. Pre-specified study and intervention characteristics were examined in the meta-regression at these time-points including number of sessions, duration of intervention, method of delivery and risk of bias (Table S7) and none were found to have any impact on the effect estimates on weight or BMI reported in the pairwise meta-analysis. There were too few studies in each stratum to analyse the potential effects of comorbidities (e.g., diabetes). Due to the small number of studies, subgroup analysis was not conducted.

## Intervention adherence

There was substantial heterogeneity and poor reporting of attendance and adherence outcomes, limiting our ability to conduct any meaningful quantitative analysis (Table S8). Only 22 studies reported any attendance information, but, for all these studies, attendance was at least 60% at group sessions overall, and eight [31,35,42,46,54,69,71,72] out of 11 RCTs reporting attendance information for each group had a 3wCBT group with higher attendance than the control arm. Information provided on adherence included minutes of home meditation practice, number of mindful meals per week, food and exercise diaries, and completion of online modules. Generally, within each study, there seemed to be a spread of engagement in the home practice aspect of interventions. This also varied with interventions delivered via internet: one study[44] found a median completion of all modules was 91%, and another[34] found a mean of 32%.

## DISCUSSION

This comprehensive systematic review and network meta-analysis found high quality evidence suggesting that 3wCBT results in greater weight loss than no/minimal intervention. Importantly, it also found moderate quality evidence that suggests 3wCBT results in greater weight loss than SBT at post-intervention and high quality evidence from a small number of studies indicating that 3wCBT results in greater weight loss than SBT at longer-term follow-up. However, it is important to note that 3wCBTs did not consistently outperform other interventions across shorter follow-up times (e.g. 3- and 9-months) and that differences in weight change between 3wCBT and SBT were small (approximately 0.6kg difference post-intervention and 1.4kg difference at 24 months). Future research is needed to establish the clinical significance of these small differences in weight change.

The finding that 3wCBT is potentially more effective than SBT contrasts with the report by Roche et al.[14] that acceptance- and mindfulness-based interventions were only more effective than waitlist control arms. Conversely, estimates for the difference in weight loss between CBT and no/minimal intervention in our analysis are slightly smaller. This may be because Roche et al.[14] merged short and long-term follow-up data, and included participants with a BMI <25 kg/m$^2$, either of which may be associated with larger effects. Comparisons with other reviews that purport to have compared 3wCBT with other approaches are more challenging because of less appropriate statistical approaches. Both Carrière et al.[15] and Rogers et al.[13] combined the estimates from both RCTs and single-arm pre-post studies. While the analytic methods used in Carrière et al.[15] is unclear, Rogers et al.[13] used only the post-intervention estimates for the RCTs (which ignores baseline differences between groups that may be influential in smaller studies),[82] and effect estimates

were weighted by sample size, not SD. Consequently, the reported study-specific estimates are different between Rogers et al.[13] and Roche et al.[14] even though both label the effect as Hedges g.[15,59].

Our statistical approach was more rigorous. In the pairwise meta-analysis we only included RCTs, we applied a consistent definition of 'change' estimate as pre-minus-post estimates, we used appropriate methods for pairwise comparisons, and we further separated the effectiveness against no/minimal control or standard behavioural treatments. We reported the effect estimates by follow-up times to have more insights of the short- and longer-term effects, and we restricted our analytic population to those with a BMI ≥25 kg/m$^2$ as this is more relevant from a clinical and policy perspective.

To our knowledge, this is also the first review to report on the comparative effectiveness of individual 3wCBT types, which have never been tested in head-to-head trials. Network meta-analysis found that ACT-based interventions had the most consistent evidence of effectiveness indicating greater weight loss compared to SBT at post-intervention and 12- and 24-month follow-up from baseline; comparisons at other time-points or with other 3wCBT types either appeared to favour ACT or did not show evidence of a difference. ACT was ranked as the best intervention up to 12 months and was the only 3wCBT to have outcomes at 24 months and 36 months. Network estimates suggested MBCT resulted in greater weight loss than SBT at 12- and 18-months, but favoured SBT at 9 months and there was no evidence that MBCT was more effective than no/minimal intervention. This suggests that we should interpret the finding that MBCT was the highest-ranking intervention at 12- and 18-months with some caution. Only four studies evaluated a 3wCBT approach other than acceptance or mindfulness and these were of low quality and short follow-

up. Although we identified three studies using DBT, all used non-randomised pre-post design and one was combined with pharmacotherapy; therefore they were not included in the pairwise or network meta-analysis, limiting conclusions on DBT effectiveness. CFT was found to have no evidence for weight loss; however, this finding is based upon one unpublished thesis[41] which was deemed to be of high risk of bias, and of very low quality. To date, the evidence provides strongest support for the superiority of acceptance-based interventions. It is possible that the superiority of the acceptance-based programmes in this context is due to its focus on values and willingness to reduce experiential avoidance. However, more research is needed to confirm these differences and identify the mechanisms of action.

Changes in secondary outcomes were generally in the desired direction. Following 3wCBT there was evidence suggestive of reductions in depression, anxiety and stress, and increases in quality of life, mindfulness and psychological flexibility. There were similar reductions in binge eating, dietary disinhibition, hunger and emotional eating, and increases in dietary restraint, intuitive eating and mindful eating following 3wCBT. This is consistent with previous reviews that have reported on these outcomes.[13,15,16] Pairwise comparisons suggest that most improvements in these outcomes were greater than for no/minimal intervention. Focusing on comparisons of 3wCBT vs. SBT, pairwise comparisons showed that reductions in disinhibition and increases in mindful eating were greater for 3wCBT but no differences in other psychological factors. These could represent important mechanisms by which 3wCBT has a greater effect on weight control than SBT and warrant further investigation. Few studies reported changes in blood pressure, glycaemia, lipid profile, and waist circumference, and pairwise comparisons only suggested greater reductions in glycaemia.

Meta-regression did not identify any specific intervention characteristics (e.g., duration, mode of delivery, number of sessions) that were more effective than others. This may have been due to the small number of studies. Similar to traditional behavioural weight management programmes, the majority of interventions were delivered in a group face to face format. Such delivery has often been found to be effective in weight loss,[83] with the group providing peer support and regular encouragement, particularly for those experiencing social isolation. However, closed group programmes led by clinical psychologists can be logistically difficult and costly to deliver, particularly in the context of national health services providing free or discounted healthcare. Increasingly, standard behavioural weight management interventions are moving to more scalable methods of delivery to increase reach and reduce cost. Only four interventions[34,44,74,79] in our review used remote delivery through internet or mobile phone. Similarly, a review of online mindful eating interventions[18] found only two studies focusing on weight loss, and none were delivered through mobile telephone, highlighting a dearth of investigation into this research area. Greater consideration may need to be given to the use of digital technology to facilitate intervention delivery, with its 24-hour accessibility, improved scalability and increased reach.[84]

**Strengths and limitations**

The study of 3wCBT for weight management is in its relative infancy, with the earliest included RCTs from 2008[33] (MBCT) and 2011[30] (ACT). While a number of RCTs have been conducted, most have had small samples, short follow-up and few provide high quality evidence. Only three RCTs reported outcomes beyond 12-months despite 3wCBT being hypothesised to have particular benefit for long-term outcomes. However, these studies with longer term follow-up had low risk of bias

and provided high quality evidence. The small number of studies limited our network meta-analysis to up to 18-months post-baseline and meant that there were insufficient studies to conduct meaningful meta-regression on the most effective intervention components and characteristics beyond 6 months. Many studies also had very small sample sizes. The small number of studies and small sample sizes meant that many of our estimates had wide confidence intervals, thereby limiting the power to detect a difference. Many of the studies included in this review had high or serious risk of bias. However, it should be noted that we used a stringent assessment tool, and heterogeneity for many outcomes was low. For some studies this may also reflect the slowness of the obesity field to adopt standards for trial reporting (e.g., CONSORT),[23] rather than the quality of the research itself. It is also important to note that the studies with longer-term follow-up (i.e. 12 and 24 months from baseline) were of high quality, based upon the GRADE assessment tool,[27] so we can have greater confidence in the findings at these time points.

There was heterogeneity in the content of 3wCBT programmes, with a combination of standardised, modified and novel programmes that varied in length and practice time. Some studies evaluated interventions that used combinations of different third-wave therapies, which may obscure potential differences between types of therapy. However, this is a reflection of how these interventions are used. In attempting to collate adherence and attendance data, we found a low number of studies reporting intervention fidelity information and substantial variability in reporting. 3wCBTs seem to have comparable attendance and attrition rates to standard behavioural programmes,[85] suggesting they are an acceptable and feasible option. Lack of information stopped us from conducting a meta-regression to try to identify sources of heterogeneity in attendance or adherence.

Studies in our review had a high proportion of female participants; this is typical in weight loss programmes and mindfulness interventions.[86] This limits generalisability of findings to males,[83] and warrants purposive recruitment of males to studies and weight loss programmes per se. Furthermore, several studies lacked detail of participant demographics such as ethnicity and socio-economic status; more complete reporting would enable us to understand the extent of the generalisability of results.

There are several strengths to this review. RCTs and pre-post studies were included in our pooled estimates, but only RCTs were included in pairwise and network meta-analysis to provide the estimates of the comparative effectiveness against a comparator. By conducting a network analysis, we could estimate comparisons between different types of 3wCBT that have not been directly compared, incorporating direct, indirect and mixed evidence in our evaluations of the evidence. To maximise on relevant research, we included unpublished theses and contacted authors regarding abstracts in conference proceedings. Unlike previous reviews,[14] we restricted our analytic population to those with a BMI ≥25 kg/m$^2$ to make our results more relevant to healthcare policies that recommend weight management interventions for people with overweight/obesity.

**Conclusions**

This systematic review and network meta-analysis found moderate quality evidence suggesting that third wave cognitive behavioural therapy results in a small increase in weight loss compared to standard behavioural treatment at post-intervention. It found high quality evidence from a small number of studies suggesting that third wave cognitive behavioural therapy results in greater weight loss than standard behavioural treatment at 12 and 24 month follow-up from baseline. Evidence

specifically appears to support the use of acceptance-based programmes. More large, high-quality trials are needed in this area to better understand who these interventions work for and how they work, so that we can target these interventions appropriately and identify the most crucial components and "active ingredients". Future research should also consider how we deliver these interventions in a cost-effective way that maximises scalability while maintaining effectiveness.

## REFERENCES


1. Curioni CC, Lourenc PM. Long-term weight loss after diet and exercise: a systematic review. *Int J Obes*. 2005;29:1168-1174. doi:10.1038/sj.ijo.0803015
2. Forman EM, Butryn ML, Manasse M, Bradley LE. Acceptance-based behavioral treatment for weight control: a review and future directions. *Curr Opin Psychol*. 2015;2:87-90. doi:10.1016/j.copsyc.2014.12.020.
3. Hartmann-Boyce J, Johns DJ, Jebb SA, Summerbell C, Aveyard P. Behavioural weight management programmes for adults assessed by trials conducted in everyday contexts: systematic review and meta-analysis. *Obes Rev*. 2014;15(11):920-932. doi:10.1111/obr.12220
4. Barte JCM, Ter Bogt NCW, Bogers RP, et al. Maintenance of weight loss after lifestyle interventions for overweight and obesity, a systematic review. *Obes Rev*. 2010;11:899-906. doi:10.1111/j.1467-789X.2010.00740.x
5. Dombrowski S, Knittle K, Avenell a, Araujo-Soares V, Sniehotta F. Long term maintenance of weight loss with non-surgical interventions in obese adults: systematic review and meta-analyses of randomised controlled trials. *BMJ*. 2014;348:g2646. doi:10.1136/bmj.g2646
6. Dietz WH, Baur LA, Hall K, et al. Management of obesity: improvement of health-care

training and systems for prevention and care. *Lancet*. 2015;385:2521-2533. doi:10.1016/S0140-6736(14)61748-7

7. NICE guideline. Obesity: identification, assessment and management. Clinical guideline [CG189]. 2014.

8. Hayes SC, Villatte M, Levin M, Hildebrandt M. Open, Aware, and Active: Contextual Approaches as an Emerging Trend in the Behavioral and Cognitive Therapies. *Annu Rev Clin Psychol*. 2011;7:141-168. doi:10.1146/annurev-clinpsy-032210-104449

9. Hayes SC. Acceptance and commitment therapy, relational frame theory, and the third wave of behavioral and cognitive therapies. *Behav Ther*. 2004;35(4):639-665. doi:10.1016/S0005-7894(04)80013-3

10. Linardon J, Fairburn CG, Fitzsimmons-Craft EE, Wilfley DE, Brennan L. The empirical status of the third-wave behaviour therapies for the treatment of eating disorders: A systematic review. *Clin Psychol Rev*. 2017;58:125-140. doi:10.1016/j.cpr.2017.10.005

11. Olson KL, Emery CF. Mindfulness and weight loss: A systematic review. *Psychosom Med*. 2015;77(1):59-67. doi:10.1097/PSY.0000000000000127

12. O'Reilly GA, Cook L, Spruijt-Metz D, Black DS. Mindfulness-based interventions for obesity-related eating behaviours: A literature review. *Obes Rev*. 2014;15(6):453-461. doi:10.1111/obr.12156

13. Rogers JM, Ferrari M, Mosely K, Lang CP, Brennan L. Mindfulness-based interventions for adults who are overweight or obese: a meta-analysis of physical and psychological health outcomes. *Obes Rev*. 2017;18(1):51-67. doi:10.1111/obr.12461

14. Roche AI, Kroska EB, Denburg NL. Acceptance- and mindfulness-based interventions for health behavior change: Systematic review and meta-analyses. *J Context Behav Sci*. 2019;13:74-93. doi:10.1016/j.jcbs.2019.06.002

15. Carrière K, Khoury B, Günak MM, Knäuper B. Mindfulness-based interventions for

weight loss: a systematic review and meta-analysis. *Obes Rev*. 2018;19(2):164-177. doi:10.1111/obr.12623

16. Ruffault A, Czernichow S, Hagger MS, et al. The effects of mindfulness training on weight-loss and health-related behaviours in adults with overweight and obesity: A systematic review and meta-analysis. *Obes Res Clin Pract*. 2017;11:90-111. doi:10.1016/j.orcp.2016.09.002

17. Katterman SN, Kleinman BM, Hood MM, Nackers LM, Corsica JA. Mindfulness meditation as an intervention for binge eating, emotional eating, and weight loss: A systematic review. *Eat Behav*. 2014;15(2):197-204. doi:10.1016/j.eatbeh.2014.01.005

18. Lyzwinski LN, Caffery L, Bambling M, Edirippulige S. A Systematic Review of Electronic Mindfulness-Based Therapeutic Interventions for Weight, Weight-Related Behaviors, and Psychological Stress. *Telemed e-Health*. 2018;24(3). doi:10.1089/tmj.2017.0117

19. Public Health England. *National Mapping of Weight Management Services; Provision of Tier 2 and Tier 3 Services in England*. 2015.

20. Curry SJ, Krist AH, Owens DK, et al. Behavioral weight loss interventions to prevent obesity-relatedmorbidity and mortality in adults US preventive services task force recommendation statement. *JAMA*. 2018;320(11):1163-1171. doi:10.1001/jama.2018.13022

21. Lawlor ER, Islam N, Griffin SJ, Hill AJ, Hughes CA, Ahern AL. Third-wave cognitive behaviour therapies for weight management: Systematic review and network meta-analysis protocol. *BMJ Open*. 2018;8:e023425. doi:10.1136/bmjopen-2018-023425

22. The Cochrane Public Health Group. Cochrane Public Health Group Data Extraction and Assessment Template. 2011:1-22.

23. Schulz KF, Altman DG, Moher D, et al. CONSORT 2010 Statement: updated guidelines for reporting parallel group randomised trials. *BMC Med*. 2010;8:18.

doi:10.1186/1741-7015-8-18

24. Hoffmann TC, Glasziou PP, Boutron I, et al. Better reporting of interventions: Template for intervention description and replication (TIDieR) checklist and guide. *BMJ*. 2014;348:g1687. doi:10.1136/bmj.g1687

25. Higgins JPT, Sterne JAC, Savović J, Page MJ, Hróbjartsson A, Boutron I, Reeves B, Eldridge S. A revised tool for assessing risk of bias in randomized trials In: Chandler J, McKenzie J, Boutron I, Welch V (editors). Cochrane Methods. *Cochrane Database of Systematic Reviews* 2016, Issue 10 (Suppl 1). dx.doi.org/10.1002/14651858.CD201601.

26. Sterne JA, Hernán MA, Reeves BC, et al. ROBINS-I: A tool for assessing risk of bias in non-randomised studies of interventions. *BMJ*. 2016;355:i4919. doi:10.1136/bmj.i4919

27. Guyatt GH, Oxman A, Vist G, et al. GRADE an emerging consensus on rating quality of evidence and stren. *BMJ*. 2008;336:924. doi:10.1136/bmj.39489.470347.AD

28. Braun TD, Park CL, Conboy LA. Psychological Well-Being, Health Behaviors, and Weight Loss Among Participants in a Residential Kripalu Yoga-Based Weight Loss Program. *Int J Yoga Therap*. 2012;22:9-22.

29. Dalen J, Smith BW, Shelley BM, Sloan AL, Leahigh L, Begay D. Pilot study: Mindful Eating and Living (MEAL): Weight, eating behavior, and psychological outcomes associated with a mindfulness-based intervention for people with obesity. *Complement Ther Med*. 2010;18:260-264. doi:10.1016/j.ctim.2010.09.008

30. Fletcher LB. A Mindfulness and Acceptance-based Intervention for Increasing Physical Activity and Reducing Obesity. *Dissertation*. 2011.

31. Goldbacher E, La Grotte C, Komaroff E, Vander Veur S, Foster GD. An initial evaluation of a weight loss intervention for individuals who engage in emotional

eating. *J Behav Med*. 2016;39:139-150. doi:10.1007/s10865-015-9678-6

32. Raja-Khan N, Agito K, Shah J, et al. Mindfulness-Based Stress Reduction in Women with Overweight or Obesity: A Randomized Clinical Trial. *Obesity*. 2017;25:1349-1359. doi:10.1002/oby.21910

33. Blevins NC. Mindfulness meditation as an intervention for body image and weight management in college women: A pilot study. *Dissertation*. 2008.

34. Boucher S, Gray A, Lillis J, et al. Teaching Intuitive Eating and Acceptance and Commitment Therapy Skills Via a Web-Based Intervention: A Pilot Single-Arm Intervention Study. *JMIR Res Protoc*. 2016;5(4):e180. doi:10.2196/resprot.5861

35. Davis KK. Effect of Mindfulness Meditation and Home-Based Resistance Exercise on Weight Loss, Weight Loss Behaviors, and Psychosocial Correlates in Overweight Adults. *Dissertation*. 2008.

36. Lee TM. Comparing mindfulness-enriched weight management to current standard practices. *Dissertation*. 2017. doi:https://doi.org/10.13023/ETD.2017.054

37. Palmeira L, Cunha M, Pinto-Gouveia J. Processes of change in quality of life, weight self-stigma, body mass index and emotional eating after an acceptance-, mindfulness- and compassion-based group intervention (Kg-Free) for women with overweight and obesity. *J Health Psychol*. 2017:1-14. doi:10.1177/1359105316686668

38. Chung S, Zhu S, Friedmann E, et al. Weight loss with mindful eating in African American women following treatment for breast cancer: a longitudinal study. *Support Care Cancer*. 2016;24:1875-1881. doi:10.1007/s00520-015-2984-2

39. Gallé F, Cirella A, Salzano AM, Onofrio V Di, Belfiore P, Liguori G. Analyzing the Effects of Psychotherapy on Weight Loss after Laparoscopic Gastric Bypass or Laparoscopic Adjustable Gastric Banding in Patients with Borderline Personality Disorder: A Prospective Study. *Scand J Surg*. 2017;106(4):299-304. doi:10.1177/1457496917701670

40. Kristeller J, Wolever RQ, Sheets V. Mindfulness-Based Eating Awareness Training (MB-EAT) for Binge Eating: A Randomized Clinical Trial. *Mindfulness*. 2014;5(3):282-297. doi:10.1007/s12671-012-0179-1

41. Loader KA. A compassionate mind approach to self-help for treatment seeking obese adults: A randomised controlled trial. *Dissertation*. 2013.

42. McKee HC, Ntoumanis N. Developing self-regulation for dietary temptations: intervention effects on physical, self-regulatory and psychological outcomes. *J Behav Med*. 2014;37:1075-1081. doi:10.1007/s10865-014-9557-6

43. Roosen MA, Safer D, Adler S, Cebolla A, van Strien T. Group dialectical behavior therapy adapted for obese emotional eaters; a pilot study. *Nutr Hosp*. 2012;27(4):1141-1147. doi:10.3305/nh.2012.27.4.5843

44. Sairanen E, Tolvanen A, Karhunen L, et al. Psychological flexibility mediates change in intuitive eating regulation in acceptance and commitment therapy interventions. *Public Health Nutr*. 2017;20(9):1681-1691. doi:10.1017/s1368980017000441

45. Smith BW, Shelley BM, Sloan AL, Colleran K, Erickson K. A Preliminary Randomized Controlled Trial of a Mindful Eating Intervention for Post-menopausal Obese Women. *Mindfulness*. 2018;9(3):836-849. doi:10.1007/s12671-017-0824-9

46. Spadaro KC, Davis KK, Sereika SM, Gibbs BB, Jakicic JM, Cohen SM. Effect of mindfulness meditation on short-term weight loss and eating behaviors in overweight and obese adults: A randomized controlled trial. *J Complement Integr Med*. 2017;15(2). doi:10.1515/jcim-2016-0048

47. Godfrey KM, Gallo LC, Afari N. Mindfulness-based interventions for binge eating: a systematic review and meta-analysis. *J Behav Med*. 2015;38:348-362. doi:10.1007/s10865-014-9610-5

48. Vocks S, Tuschen-Caffier B, Pietrowsky R, Rustenbach SJ, Kersting A, Herpertz S. Meta-analysis of the effectiveness of psychological and pharmacological treatments

for binge eating disorder. *Int J Eat Disord*. 2010;43:205-217. doi:10.1002/eat.20696

49. StataCorp. Stata Statistical Software. 2015.

50. Wasserstein RL, Lazar NA. The ASA's Statement on *p* -Values: Context, Process, and Purpose. *Am Stat*. 2016;70(2):129-133. doi:10.1080/00031305.2016.1154108

51. DerSimonian R, Laird N. Meta-analysis in clinical trials. *Control Clin Trials*. 1986;7:177-188. doi:10.1016/0197-2456(86)90046-2

52. Hedges, LV; Olkin I. *Statistical Methods for Meta-Analysis*. Academic Press; 2014.

53. Salanti G, Giovane C Del, Chaimani A, Caldwell DM, Higgins JPT. Evaluating the quality of evidence from a network meta-analysis. *PLoS One*. 2014;9(7):e99682. doi:10.1371/journal.pone.0099682

54. Butryn ML, Forman EM, Lowe MR, Gorin AA, Zhang F, Schaumberg K. Efficacy of environmental and acceptance-based enhancements to behavioral weight loss treatment: The ENACT trial. *Obesity*. 2017;25:866-872. doi:10.1002/oby.21813

55. Higgins JPT, Jackson D, Barrett JK, Lu G, Ades AE, White IR. Consistency and inconsistency in network meta-analysis: concepts and models for multi-arm studies. *Res Synth Methods*. 2012;3:98-110. doi:10.1002/jrsm.1044

56. Dias S, Welton NJ, Caldwell DM, Ades AE. Checking consistency in mixed treatment comparison meta-analysis. *Stat Med*. 2010;29:932-944. doi:10.1002/sim.3767

57. Salanti G, Ades AE, Ioannidis JPA. Graphical methods and numerical summaries for presenting results from multiple-treatment meta-analysis: An overview and tutorial. *J Clin Epidemiol*. 2011;64(2):163-171. doi:10.1016/j.jclinepi.2010.03.016

58. Tobias A. Assessing the influence of a single study in the meta-analysis estimate. *Stata Tech Bull*. 1999:15-17. https://www.stata-press.com/journals/stbcontents/stb47.pdf.

59. Higgins JPT , Green S, ed. *Cochrane Handbook for Systematic Reviews of*

*Interventions Version 5.1.0 (Updated March 2011)*. The Cochrane Collaboration; 2011. www.handbook.cochrane.org.

60. Lappalainen R, Sairanen E, Järvelä E, et al. The effectiveness and applicability of different lifestyle interventions for enhancing wellbeing: the study design for a randomized controlled trial for persons with metabolic syndrome risk factors and psychological distress. *BMC Public Health*. 2014;14:310. doi:10.1186/1471-2458-14-310

61. Raja-Khan N, Agito K, Shah J, et al. Mindfulness-based stress reduction for overweight/obese women with and without polycystic ovary syndrome: Design and methods of a pilot randomized controlled trial. *Contemp Clin Trials*. 2015;41:287-297. doi:10.1016/j.cct.2015.01.021

62. Lillis J, Niemeier HM, Ross KM, et al. Weight loss intervention for individuals with high internal disinhibition: design of the Acceptance Based Behavioral Intervention (ABBI) randomized controlled trial. *BMC Psychol*. 2015;3:17. doi:10.1186/s40359-015-0075-2

63. Mattila E, Lappalainen R, Välkkynen P, Sairanen E, Lappalainen P. Usage and Dose Response of a Mobile Acceptance and Commitment Therapy App: Secondary Analysis of the Intervention Arm of a Randomized Controlled Trial. *JMIR Mhealth Uhealth*. 2016;4(3):e90. doi:10.2196/mhealth.5241

64. Hamel REG. Weight loss and psychosocial effects of a mindfulness-based intervention in overweight adults: a pilot study. *Dissertation*. 2010.

65. Braun TD, Noggle JJ, Gorin AA, Garivaltis H, Conboy LA, Park CL. Group-Based Yogic Weight Loss with Ayurveda-Inspired Components: A Pilot Investigation of Female Yoga Practitioners and Novices. *Int J Yoga Therap*. 2016;26:55-72. doi:10.17761/1531-2054-26.1.55

66. Adler S. Orlistat/Alli compared to Orlistat/Alli plus dialectical behavior therapy in overweight binge eaters: A randomized control trial. *Dissertation*. 2008.

67. Daubenmier J, Kristeller J, Hecht FM, et al. Mindfulness Intervention for Stress Eating to Reduce Cortisol and Abdominal Fat among Overweight and Obese Women: An Exploratory Randomized Controlled Study. *J Obes*. 2011:1-13. doi:10.1155/2011/651936

68. Daubenmier J, Moran PJ, Kristeller J, et al. Effects of a mindfulness-based weight loss intervention in adults with obesity: A randomized clinical trial. *Obesity*. 2016;24:794-804. doi:10.1002/oby.21396

69. Miller CK, Kristeller JL, Headings A, Nagaraja H, Miser WF. Comparative Effectiveness of a Mindful Eating Intervention to a Diabetes Self-Management Intervention among Adults with Type 2 Diabetes: A Pilot Study. *J Acad Nutr Diet*. 2012;112:1835-1842. doi:10.1016/j.jand.2012.07.036

70. Palmeira L, Pinto-Gouveia J, Cunha M. Exploring the efficacy of an acceptance, mindfulness & compassionate-based group intervention for women struggling with their weight (Kg-Free): A randomized controlled trial. *Appetite*. 2017;112:107-116. doi:10.1016/j.appet.2017.01.027

71. Forman EM, Butryn ML, Juarascio AS, et al. The Mind Your Health project: A randomized controlled trial of an innovative behavioral treatment for obesity. *Obesity*. 2013;21(6):1119-1126. doi:10.1002/oby.20169

72. Forman EM, Butryn ML, Manasse SM, et al. Acceptance-based versus standard behavioral treatment for obesity: Results from the Mind Your Health randomized controlled trial. *Obesity*. 2016;24(10):2050-2056. doi:10.1002/oby.21601

73. Lillis J, Niemeier HM, Thomas JG, et al. A randomized trial of an acceptance-based behavioral intervention for weight loss in people with high internal disinhibition. *Obesity*. 2016;24(12):2509-2514. doi:10.1002/oby.21680

74. Carpenter KM, Vickerman KA, Salmon EE, Javitz HS, Epel ES, Lovejoy JC. A Randomized Pilot Study of a Phone-Based Mindfulness and Weight Loss Program.

*Behav Med*. 2017;6:1-11. doi:10.1080/08964289.2017.1384359

75. Niemeier HM, Leahey T, Palm Reed K, Brown RA, Wing RR. An Acceptance-Based Behavioral Intervention for Weight Loss: A Pilot Study. *Behav Ther*. 2012;43(2):427-435. doi:10.1016/j.beth.2011.10.005

76. Andalcio AA. Implementation of a Lifestyle Intervention Program in the Primary Care Setting to Decrease Body Mass Indices in Obese Adults. *Dissertation.* 2018.

77. Hanson P, Shuttlewood E, Halder L, et al. Application of Mindfulness in a Tier 3 Obesity Service Improves Eating Behavior and Facilitates Successful Weight Loss. *J Clin Endocrinol Metab*. 2019;104(3):793-800. doi:10.1210/jc.2018-00578.

78. Lundgren JD. A mindfulness-based behavioral treatment for weight loss. *Dissertation*. 2003.

79. Bradley LE, Forman EM, Kerrigan SG, et al. Project HELP: a Remotely Delivered Behavioral Intervention for Weight Regain after Bariatric Surgery. *Obes Surg*. 2017;27(3):586-598. doi:10.1007/s11695-016-2337-3

80. Forman EM, Butryn ML, Hoffman KL, Herbert JD. An Open Trial of an Acceptance-Based Behavioral Intervention for Weight Loss. *Cogn Behav Pract*. 2009;16(2):223-235. doi:10.1016/j.cbpra.2008.09.005

81. Butryn ML, Phelan S, Hill JO, et al. Consistent Self-monitoring of Weight : A Key Component of Successful Weight Loss Maintenance. *Obesity*. 2007;15(12):3091-3096. doi:10.1038/oby.2007.368.

82. Johnsen TJ, Friborg O. The effects of cognitive behavioral therapy as an anti-depressant treatment is falling: A meta-analysis. *Psychol Bull*. 2015;141(4):747-768. doi:http://dx.doi.org/10.1037/bul0000015.

83. Borek AJ, Abraham C, Greaves CJ, Tarrant M. Group-Based Diet and Physical Activity Weight-Loss Interventions : A Systematic Review and Meta-Analysis of

Randomised Controlled Trials. *Appl Psychol Heal Well-Being*. 2018;10(1):62-86. doi:10.1111/aphw.12121

84. Beleigoli AM, Andrade AQ, Cançado AG, et al. Web-Based Digital Health Interventions for Weight Loss and Lifestyle Habit Changes in Overweight and Obese Adults : Systematic Review and Meta-Analysis. *J Med Internet Res.* 2019;8(21):e298. doi:10.2196/jmir.9609

85. Caplan W, Bowman JD, Pronk NP. Weight-Loss Outcomes: A Systematic Review and Meta-Analysis of Weight-Loss Clinical Trials with a Minimum 1-Year Follow-Up. *J Am Diet Assoc*. 2007;107:1755-1767. doi:10.1016/j.jada.2007.07.017.

86. Pagoto SL, Schneider KL, Oleski JL, Luciani JM, Bodenlos JS, Whited MC. Male inclusion in randomized controlled trials of lifestyle weight loss interventions. *Obesity*. 2012;20(6):1234-1239. doi:10.1038/oby.2011.140

87. Daubenmier J, Lin J, Blackburn E, et al. Changes in stress, eating, and metabolic factors are related to changes in telomerase activity in a randomized mindfulness intervention pilot study. *Psychoneuroendocrinology*. 2012; 37:917-928. doi:10.1016/j.psyneuen.2011.10.008.

88. Mason AE, Epel ES, Aschbacher K, et al. Reduced reward-driven eating accounts for the impact of a mindfulness-based diet and exercise intervention on weight loss: Data from the SHINE randomized controlled trial. *Appetite*. 2016; 100: 86-93. ttp://dx.doi.org/10.1016/j.appet.2016.02.009.

89. Miller CK, Kristeller JL, Headings A, Nagaraja H. Comparison of a Mindful Eating Intervention to a Diabetes Self-Management Intervention Among Adults with Type 2 Diabetes: A Randomized Controlled Trial. *Health Educ Behav.* 2014; 41(2):145-154. doi:10.1177/1090198113493092

90. Spadaro KC. Weight loss: Exploring self-regulation through mindfulness meditation. *Dissertation.* 2008.

91. Schumacher LM, Godfrey KM, Forman EM, Butryn ML. Change in domain-specific but not general psychological flexibility relates to greater weight loss in acceptance-based behavioral treatment for obesity. *J Contextual Behav Sci.* 2019;12:59-65. https://doi.org/10.1016/j.jcbs.2019.01.008

92. Forman EM, Manasse SM, Butryn ML, et al. Long-term Follow-up of the Mind Your Health Project: Acceptance-Based versus Standard Behavioral Treatment for Obesity. *Obesity.* 2019; 27(4):565-571. doi:10.1002/oby.22412.

93. Lillis J, Thomas JG, Niemeier HM, Wing RR. Exploring process variables through which acceptance-based behavioral interventions may improve weight loss maintenance. *J Contextual Behav Sci.* 2017; 6: 398-403. http://dx.doi.org/10.1016/j.jcbs.2017.07.005

94. Järvelä-Reijonen E, Karhunen L, Sairanen E, et al. The effects of acceptance and commitment therapy on eating behaviour and diet delivered through face-to-face contact and a mobile app: a randomized controlled trial. *Int J Behav Nutr Phys Act*. 2018;15:22. doi: 10.1186/s12966-018-0654-8.

95. Bradley LE. A remote, acceptance-based intervention for weight regain after bariatric surgery. *Dissertation.* 2015.

Figure 1: PRISMA flow diagram

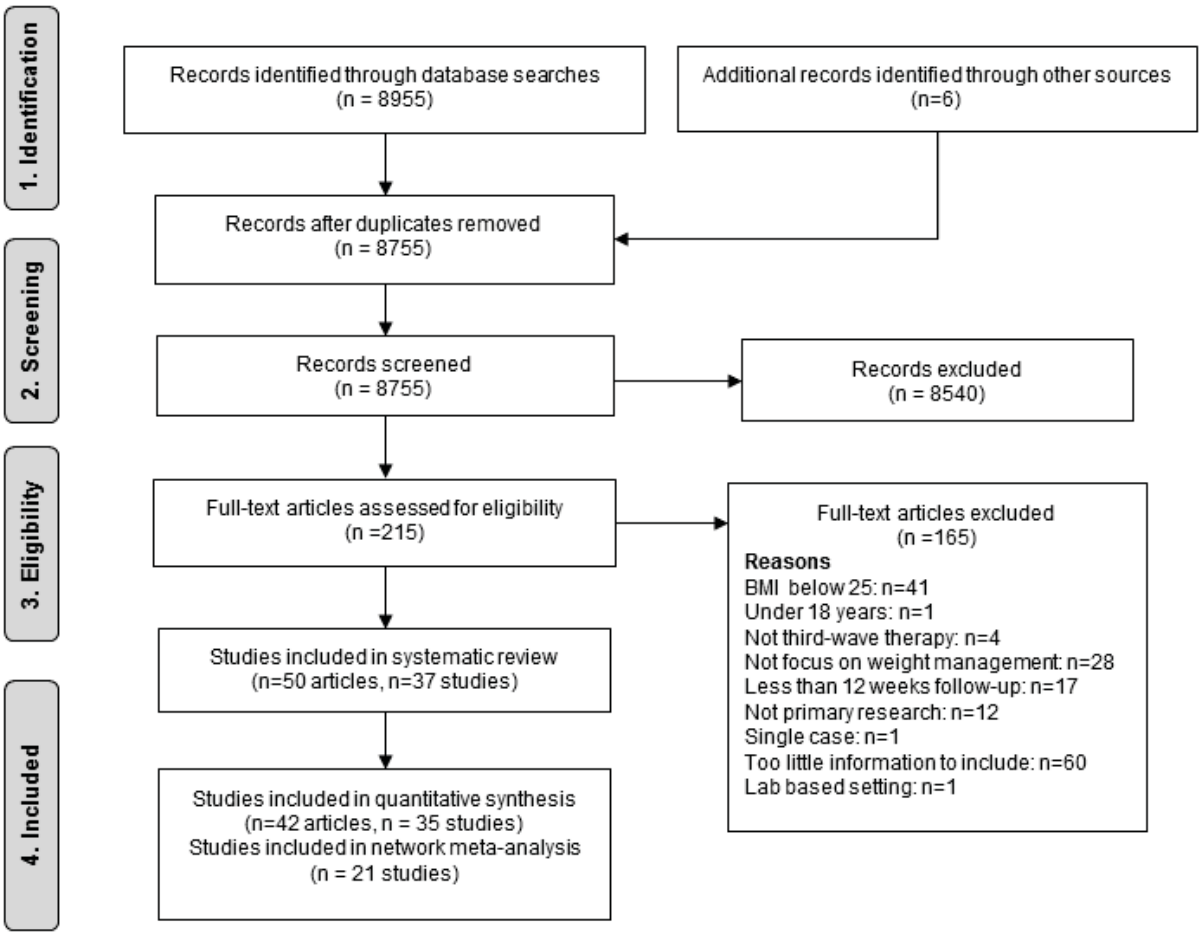


Figure 2: Weight change comparing third-wave CBT and no/minimal or standard behavioural treatment from random-effects pairwise meta-analysis

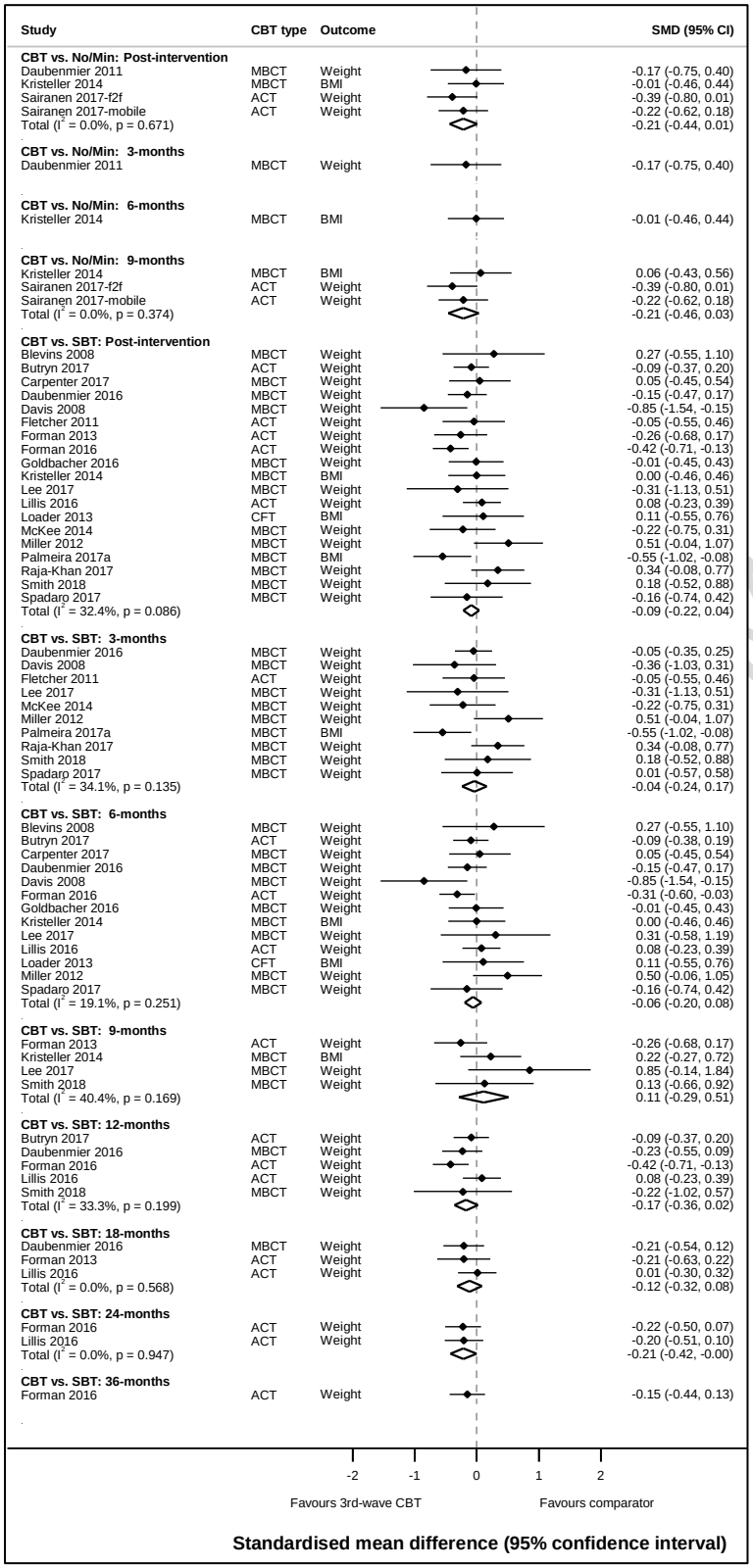



Figure 2 legends: Time-points are months since baseline unless otherwise specified; No/min: No/minimal intervention; SBT: Standard behavioural treatment; CBT: Cognitive behaviour therapy; MBCT: Mindfulness-based cognitive behaviour treatment;

ACT: Acceptance and commitment therapy; CFT: Compassion-focussed therapy; BMI: Body mass index; SMD: Standardised mean difference; CI: Confidence interval.

Figure 3: Network of interventions at different follow-up from baseline time points

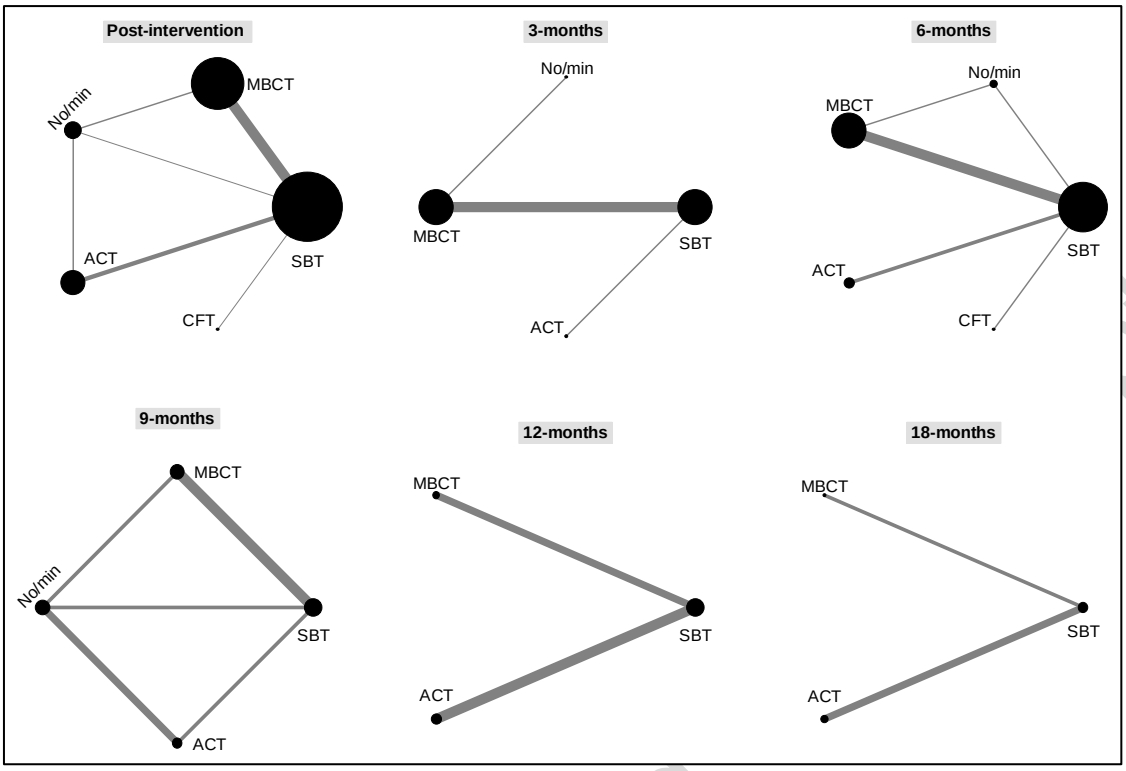



Figure 3 legends: No/min: No/minimal intervention; SBT: Standard behavioural treatment; MBCT: Mindfulness-based cognitive behaviour treatment; ACT: Acceptance and commitment therapy; CFT: Compassion-focussed therapy

Nodes are weighted by the number of studies involved in each intervention while the edges are weighted by the number of studies involved in each comparison. Time-points are months since randomisation unless otherwise specified.

Figure 4: Summary of weight change from network meta-analysis at different follow-up from baseline time points

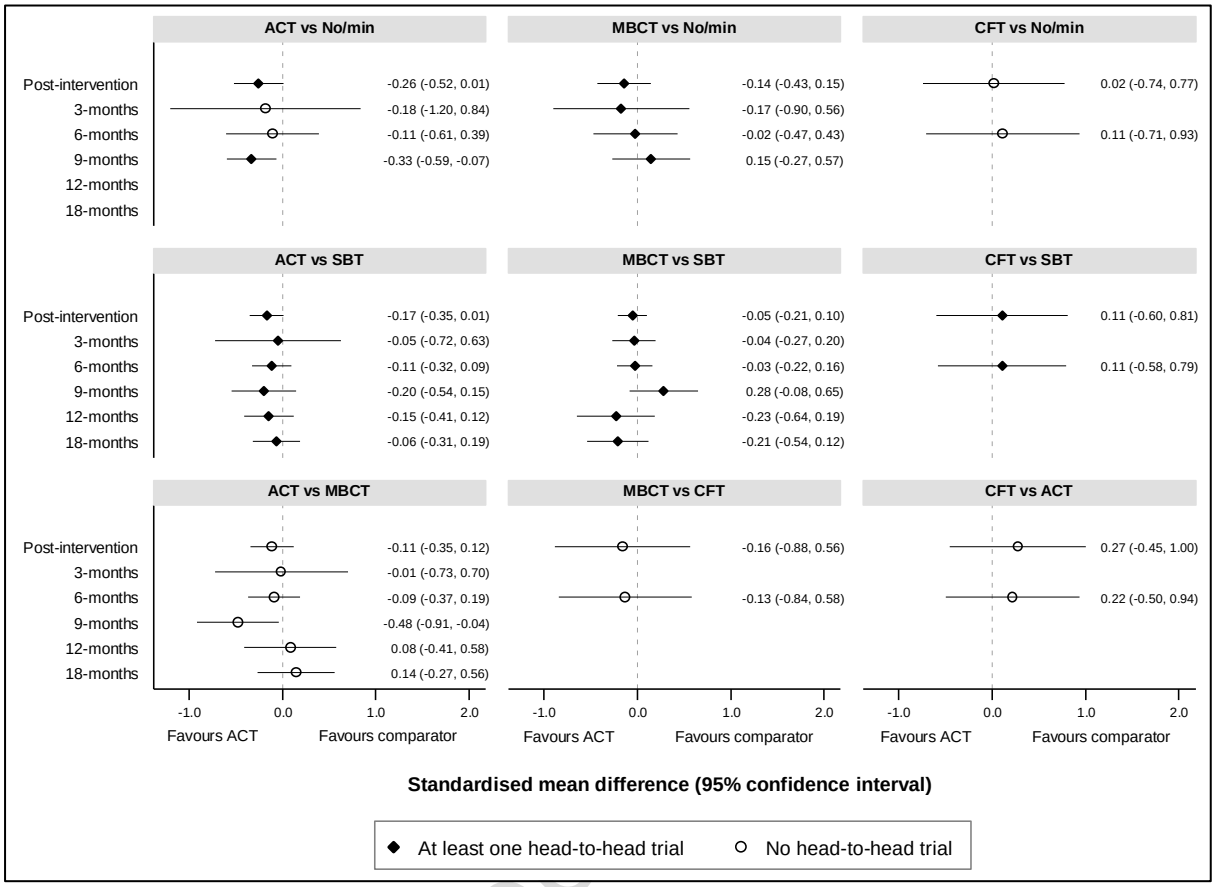
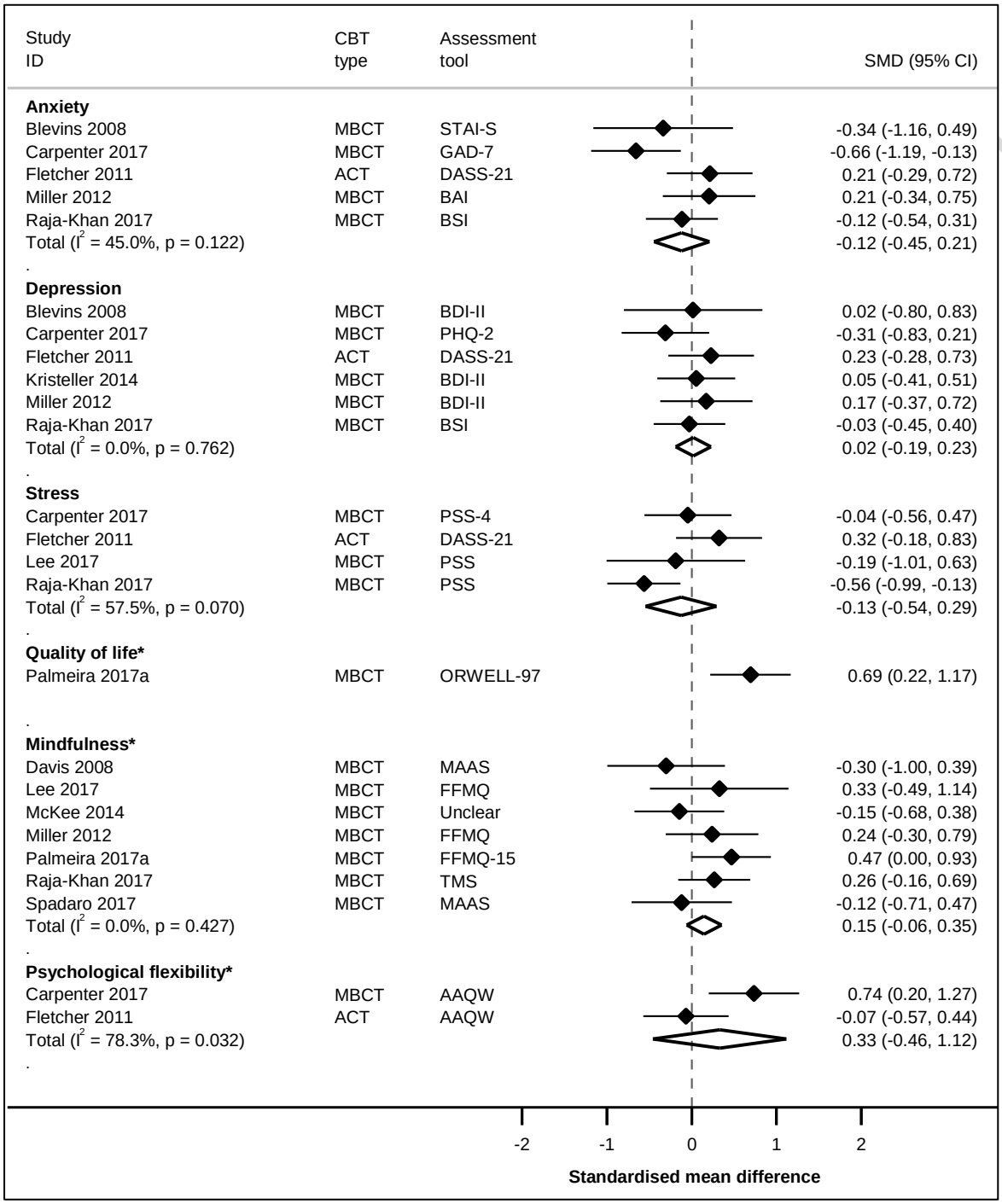


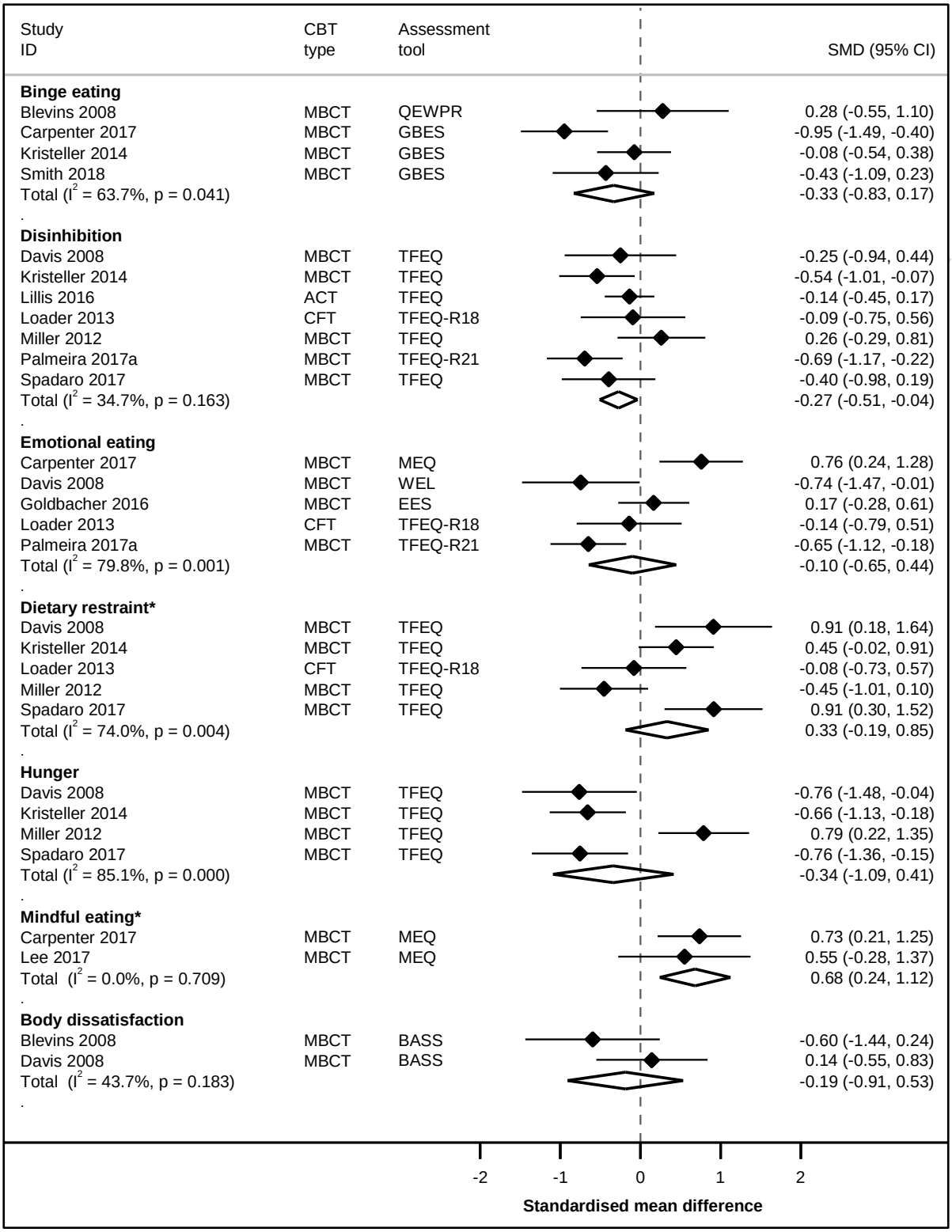

Figure 4 legends: No/min: No/minimal intervention; SBT: Standard behavioural treatment; MBCT: Mindfulness-based cognitive behaviour treatment; ACT: Acceptance and commitment therapy; CFT: Compassion-focussed therapy.
Time-points are months since baseline unless otherwise specified.

Figure 5: Changes in secondary outcomes comparing third-wave cognitive behaviour therapy and standard behavioural treatment at earliest time point post-intervention using random-effects pairwise meta-analysis

5a: Psychological outcomes



## 5b: Eating behaviours



## 5c: Physical health outcomes

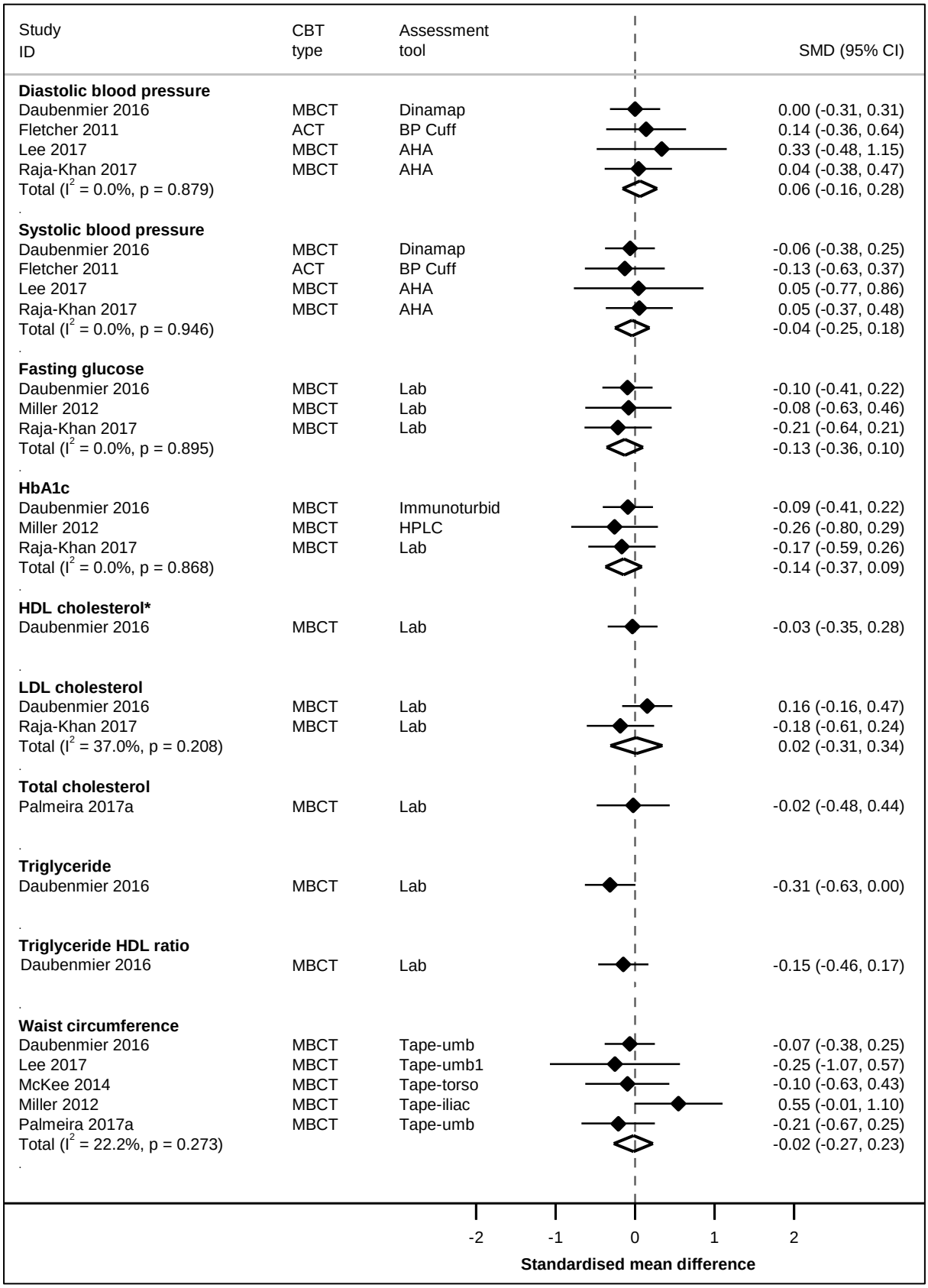



**Figure 5a-c legends**: * For these variables, estimates to the right of the dotted line indicate a desired change in favour of third-wave CBTs; for all other variables, it is to the left of the dotted line.

CBT: Cognitive behaviour therapy; MBCT: Mindfulness-based cognitive behaviour treatment; ACT: Acceptance and commitment therapy; CFT: Compassion-focussed therapy; CI: Confidence interval.

AAQ-2: Acceptance and Action Questionnaire–2; AAQW: Acceptance and Action Questionnaire for Weight; AHA: American Heart Association guidelines; BAI: Beck Anxiety Inventory (21-item); BASS: Body Areas Satisfaction Scale; BDI: Beck Depression Inventory (1961); BDI-II: Beck Depression Inventory–II (1996); BIA–O: Body Image Assessment–Obesity; BP Cuff: Digital blood pressure cuff; BSI: Brief Symptom Inventory; DASS–21: Depression Anxiety Stress Scales (21-item); DEBQ: Dutch Eating Behavior Questionnaire; Dinamap: GE/Critikon Dinamap Pro 300; EDI–II: Revised Eating Disorder Inventory–Body Dissatisfaction Subscale; EES: Emotional Eating Scale; FFMQ: Five Facets of Mindfulness Questionnaire; FFMQ–15: Five Facet Mindfulness Questionnaire–15; GAD–7: Generalized anxiety disorder–7; GBES: Gormally Binge Eating Scale; HPLC: High performance liquid chromatography; HPLP–II: Health-Promoting Lifestyle Profile II; IES: Intuitive Eating Scale scores; IES–2: Intuitive Eating Scale scores–2; Immunoturbid: Immunoturbidimetry ; IWQOL–Lite: The Impact of Weight on Quality of Life–Lite; Lab: Standard laboratory procedure; MAAS: Mindfulness Attention Awareness Scale; MEQ: Mindful Eating Questionnaire; MEQ–Dutch: Mindful Eating Questionnaire–Dutch version; ORWELL-97: Obesity Related Well-Being Questionnaire; PHQ–2: Patient Health Questionnaire–2; PMS: Philadelphia Mindfulness Scale; PSS: Perceived Stress Scale; PSS–4: Perceived Stress Scale–4; QEWPR: Questionnaire of Eating and Weight Patterns–Revised; QoLI: Quality of Life Inventory; RAND–36: RAND–36; SCL–90: Hopkins Symptom Checklist–90; SIBID–S: Situational Inventory of Body Image Dysphoria–Short Form; STAI–S: State–Trait Anxiety Inventory–State Scale; STAI–T: State–Trait Anxiety Inventory–Trait Scale; Tape–iliac: Tape measure, just above the right iliac crest at the mid-axillary line; Tape–torso: Tape measure, at the narrowest part of the torso between the iliac crest and the xiphoid process; Tape–umb: Tape measure, at the umbilicus; Tape–umb1: Tape measure, 1-inch above umbilicus; TFEQ: Three-Factor Eating Questionnaire; TFEQ–R18: Three-Factor Eating Questionnaire–R18; TFEQ–R21: Three Factor Eating Questionnaire–R21; TMS: Toronto Mindfulness Scale; Unclear: Not clear; WEL: Weight Efficacy Lifestyle Questionnaire (20-item).

**Table 1: Characteristics of included studies**

| | Population | | | | Intervention | | | | Comparison | Outcomes | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1st author, year | N | Age (years)* | BMI (kg/m2)* | Female; N (%) | Intervention(s) | Primary delivery mode | Group or individual | Length (months) | Comparison | Measurements | Time points** |
| **Randomised controlled trials** | | | | | | | | | | | |
| Blevins, 2008 (33) | 41 | 20.7 (1.4) | 29.6 (1.9) | 41 (100) | MBCT | Face to face | Group | 2m | SBT | Weight; Anxiety; Depression; Binge eating; Body dissatisfaction | 2m, 5m |
| Carpenter, 2017 (74) | 75 | 47.3 (10.0) | 31.5 (2.3) | 69 (92) | MBCT | Telephone & email | Individual | 6m | SBT | Weight; Anxiety; Depression; Stress; Psychological flexibility; Binge eating; Emotional eating; Mindful eating | 6m |
| Daubenmier, 2011 (67; 87) | 47 | MBCT: 40.4 (8.0); No/Min: 41.4 (6.7) | 31.2 (4.8) | 47 (100) | MBCT | Face to face | Group | 4m | No/Min | Weight; Anxiety; Stress; Disinhibition; Emotional eating; Dietary restraint; | 4m |
| Daubenmier, 2016 (68; 88) | 194 | MBCT: 47.2 (13.0); SBT: 47.8 (12.4) | MBCT: 35.4 (3.5); SBT: 35.6 (3.8) | MBCT: 79 (79); SBT: 81 (86) | MBCT | Face to face | Group | 5½m | SBT | Weight; DBP; SBP; Fasting glucose; HbA1c; HDL; LDL; TG; TG HDL ratio; Waist circumference | 3m, 6m, 12m, 18m |
| Davis, 2008 (35) | 71 | 45.1 (8.3) | 32.9 (3.7) | 63 (89) | MBCT | Face to face | Group | 6m | SBT, SBT+RE | Weight; Mindfulness; Disinhibition; Emotional eating; Dietary restraint; Hunger; Body dissatisfaction | 3m, 6m |
| Goldbacher, 2016 (31) | 79 | 45.6 (10.5) | 36.2 (4.1) | 75 (95) | MBCT | Face to face | Group | 5m | SBT | Weight; Emotional eating | 5m |
| Kristeller, 2014 (40) | 150 | 46.6 | 40.3 | 132 (88) | MBCT | Face to face | Group | 5¼m | SBT, No/Min | BMI; Depression; Binge eating; Disinhibition; Dietary restraint; Hunger | 6m, 9m |
| Lee, 2017 (36) | 53 | 47.7 (11.3) | 34.5 (4.8) | 48 (91) | MBCT | Face to face | Group | 3m | SBT | Weight; Stress; Mindfulness; Mindful eating ; DBP; SBP; Waist circumference | 3m, 6m, 9m |
| McKee, 2014 (42) | 60 | 37.6 (13.5)† | 32.6 (4.9)† | 40 (72)† | MBCT | Face to face & email | Group & individual | 2m | SBT | Weight; Mindfulness; Waist circumference | 2m, 3m |
| Miller, 2012 (69; 89) | 68 | MBCT: 53.9 (8.2); SBT: 54.0 (7.0)† | MBCT: 36.2 (1.2); SBT: 36.1 (1.2)† | 33 (63.5)† | MBCT | Face to face | Group | 6m | SBT | Weight; Anxiety; Depression; Mindfulness; Disinhibition; Dietary restraint; Hunger; Fasting glucose; HbA1c; Waist circumference | 3m, 4m, 6m |
| Palmeira, 2017 (37; 70) | 73 | MBCT: 42.0 (8.8) SBT: 42.7 (8.4) | MBCT: 34.8 (5.26) SBT: 33.7 (4.8) | 73 (100) | MBCT | Face to face | Group | 3½m | SBT | BMI; QoL; Mindfulness; Disinhibition; Emotional eating; Total cholesterol; Waist circumference | 3.5m |
| Raja-Khan, 2017 (32; 61) | 86 | 44.5 (12.5) | 38.9 (8.7) | 86 (100) | MBCT | Face to face | Group | 2m | SBT | Weight; Anxiety; Depression; Stress; Mindfulness; DBP; SBP; Fasting glucose; HbA1c; LDL | 2m, 4m |
| Smith, 2017 (45) | 40 | MBCT: 58.6 (4.7); SBT: 58.6 (5.2)† | MBCT: 34.7 (4.3); SBT: 38.2 (7.1)† | 36 (100)† | MBCT | Face to face | Group | 12m | SBT | Weight; Binge eating | 1½m, 4m, 9m, 12m |
| Spadaro, 2017 (46; 90) | 49 | 45.2 (8.2)† | 32.5 (3.7)† | 40 (87)† | MBCT | Face to face | Group | 6m | SBT | Weight; Mindfulness; Disinhibition; Dietary restraint; Hunger | 3m, 6m |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Butryn, 2017 (54; 91) | 283 | ACT: 53.2 (9.4); SBT: 53.0 (9.3); BT+E: 53.4 (10.3) | ACT: 35.2 (4.6); SBT: 35.0 (5.2); BT+E: 35.4 (5.2) | ACT: 84 (82); SBT: 67 (76); BT+E: 72 (77) | ACT | Face to face | Group | 12m | SBT, BT+E | Weight | 6m, 12m |
| Fletcher, 2011 (30) | 72 | ACT: 53.1 (11.1); SBT: 52.1 (12.6) | ACT: 36.2 (0.6); SBT: 34.7 (0.6) | 60 (83) | ACT | Face to face | Group | 1 day | SBT | Weight; Anxiety; Depression; Stress; Psychological flexibility; DBP; SBP | 1w (not weight/BMI), 3m |
| Forman, 2013 (71) | 128 | 45.7 (12.8) | 34.1 (3.6) | NR | ACT | Face to face | Group | 10m | SBT | Weight | 2½m, 5m, 10m,12m |
| Forman, 2016 (72; 92) | 190 | 51.6 (10.1) | 36.9 (5.8) | 156 (82) | ACT | Face to face | Group | 12m | SBT | Weight | 6m, 12m |
| Lillis, 2016 (62; 73; 93) | 162 | 50.2 (10.9) | 37.6 (5.3) | 138 (85) | ACT | Face to face | Group | 12m | SBT | Weight; Disinhibition | 6m, 12m, 18m, 24m |
| Sairanen, 2017 (44; 60; 63; 94) | 219 | 49.5 (7.4) | 31.3 (2.9) | 185 (85) | ACT | Face to face Mobile | Group Individual | 2m | No/Min | Weight; Mindfulness; Psychological flexibility; Disinhibition; Emotional eating; Dietary restraint; Intuitive eating | 2½m, 9m |
| Loader, 2013 (41) | 36 | 45.4 (9.5) | 46.7 (0.3) | 25 (69) | CFT | Face to face & telephone | Group & individual | 6m | SBT | BMI; Disinhibition; Emotional eating; Dietary restraint | 6m, 9m |
| Adler, 2008 (66) | 17 | 49.4 (11.4) | 37.7 (10.1) | 15 (88) | DBT+O | Face to face & website | Group & individual | 3m | SBT+O | | 3m, 4.5m |
| **Pre-post studies** | | | | | | | | | | | |
| Braun, 2012 (28) | 37 | Range: 32-65 | NR | NR | MBCT | Face to face | Group | 5 days | N/A | Weight; Mindfulness; Stress | 5d, 3m, 12m‡ |
| Braun, 2016 (65) | S1: 22; S2: 21 | S1: 48.2 (14.3); S2: 49.4 (10.7) | S1: 30.8 (4.2); S2: 35.5 (6.8) | S1: 22 (100); S2: 21 (100) | MBCT | Face to face | Group | 2½m | N/A | Weight; Emotional eating; Mindful eating | 2.5m, 5½m |
| Chung, 2016 (38) | 26 | 50.1 (9.0)† | 35.1 (4.0)† | 22 (100)† | MBCT | Face to face & telephone | Group & individual | 6m | N/A | Weight; Mindful eating | 3¼m, 6m |
| Dalen, 2010 (29) | 10 | 44 (8.7) | 36.9 (6.2) | 7 (70) | MBCT | Face to face | Group | 1½m | N/A | Weight; Anxiety; Binge eating; Depression; Dietary restraint; Disinhibition; Stress | 1½, 3m |
| Hamel 2010 (64) | 10 | 50.4 (13.2) | 29.1 (3.2) | 9 (90) | MBCT | Face to face | Group | NR | N/A | BMI; Emotional eating; Hunger; Mindful eating ; QoL | 3.25m |
| Hanson 2019 (77) | 53 | 45.6 (11.3) | 48.5 (9.2) | 16 (30.2) | MBCT | Face to face | Group | 2m | SBT | Weight; Emotional eating | ½m,1m,1½m,2m,8m |
| Lundgren, 2005 (78) | 33 | 44.8 (9.0)† | 31.1 (3.6)† | 16 (84)† | MBCT | Face to face | Group (unclear) | 5m | N/A | Weight; QoL | 5m |
| Andalcio 2018 (76) | 23 | NR | 39.9 | 21 (91.3) | ACT | Face to face & telephone | Individual | 4m | N/A | Weight; Waist circumference | 2m, 4m |
| Boucher, 2016 (34) | 40 | 44.8 (3.1) | 32.9 (6.0) | 40 (100) | ACT | Website | Individual | 3½m | N/A | BMI; Intuitive eating | 3½m, 6.5m |
| Bradley, 2017 (79; 95) | 20 | 54.3 (12.1) | NR | 17 (85) | ACT | Website & telephone | Individual | 2½m | N/A | Weight | 1¼m, 2½m, 5½m |
| Forman, 2009 (80) | 29 | 43.7 (9.8) | 35.8 (5.4) | 29 (100) | ACT | Face to face | Group | 3m | N/A | Weight; Dietary restraint; Disinhibition; Emotional eating; Mindfulness; QoL | 3m, 6m |
| Niemeier, 2012 (75) | 21 | 52.2 (7.6) | 32.8 (3.4) | 19 (91) | ACT | Face to face | Group | 6m | N/A | Weight; Dietary restraint; Disinhibition; Hunger | 6m, 9m |
| Gallé, 2017 (39) | 153 | DBT:34 (3.8) IIT: 33 (4.2) | 45.8 (6.4) | 153 (100) | DBT | Face to face | Group & individual | 12m | IIT, SBT | Weight | 12m |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Roosen, 2012 (43) | 35 | SBT: 32 (5.1)<br>39.2 (11.0) | 35.4 (2.6) | 30 (86) | DBT | Face to face | Group & individual | 5m | N/A | BMI; Depression; Dietary restraint; Disinhibition; Emotional eating | 5m, 11m |

*Mean (SD) or range; **Time since randomisation/baseline (m= months); †Among completers/participants included in analysis; ‡6- & 9-months recorded but not reported in the article. No/Min= No/minimal intervention; RE= Resistance exercise; BT+E= Behaviour therapy with environmental change; NL= Netherlands; NZ= New Zealand; IIT= Interpersonal individual treatment; S1= Study 1; S2= Study 2; MBCT= Mindfulness-based cognitive behavioural treatment; ACT= Acceptance and commitment therapy; CFT= Compassion-focussed therapy; DBT= Dialectical behavioural therapy; SBT= Standard behavioural treatment; NR= Not reported; DBT+O= DBT+Orlistat; SBT+O= SBT+Orlistat; QoL= Quality of life; BMI= Body Mass Index